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Engineering Bulletin
Mobile/Transportable Incineration Treatment

Purpose

Section 121(b) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) mandates the Environmental Protection Agency (EPA) to select remedies that "utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable" and to prefer remedial actions in which treatment "permanently and significantly reduces the volume, toxicity, or mobility of hazardous substances, pollutants, and contaminants as a principal element." The Engineering Bulletins are a series of documents that summarize the latest information available on selected treatment and site remediation technologies and related issues. They provide summaries of and references for the latest information to help remedial project managers, on-scene coordinators, contractors, and other site cleanup managers understand the type of data and site characteristics needed to evaluate a technology for potential applicability to their Superfund or other hazardous waste site. Those documents that describe individual treatment technologies focus on remedial investigation scoping needs. Addenda will be issued periodically to update the original bulletins.

Abstract

Incineration treats organic contaminants in solids and liquids by subjecting them to temperatures typically greater than 1000°F in the presence of oxygen, which causes the volatilization, combustion, and destruction of these compounds. This bulletin describes mobile/transportable incineration systems that can be moved to and subsequently removed from Superfund and other hazardous waste sites. It does not address other thermal processes that operate at lower temperatures or those that operate at very high temperatures, such as a plasma arc. It is applicable to a wide range of organic wastes and is generally not used in treating inorganics and metals. Mobile/transportable incinerators exhibit essentially the same environmental performance as their stationary counterparts. To date, 49 of the 95 records of decision (RODs) designating thermal remedies at Superfund sites have selected onsite incineration as an integral part of a preferred treatment alternative. There are 22 commercial-scale units in operation [5]*. This bulletin provides information on the technology applicability, the types of residuals resulting from the use of the technology, the latest performance data, site requirements, the status of the technology, and where to go for further information.

Technology Applicability

Mobile/transportable incineration has been shown to be effective in treating soils, sediments, sludges, and liquids containing primarily organic contaminants such as halogenated and nonhalogenated volatiles and semivolatiles, polychlorinated biphenyls (PCBs), pesticides, dioxins/furans, organic cyanides, and organic corrosives. The process is applicable for the thermal treatment of a wide range of specific Resource Conservation and Recovery Act (RCRA) wastes and other hazardous waste matrices that include pesticides and herbicides, spent halogenated and nonhalogenated solvents, chlorinated phenol and chlorinated benzene manufacturing wastes, wood preservation and wastewater sludge, organic chemicals production residues, pesticides production residues, explosives manufacturing wastes, petroleum refining wastes, coke industry wastes, and organic chemicals residues [1] [2] [4] [6 through 11] [13].

Information on the physical and chemical characteristics of the waste matrix is necessary to assess the matrix's impact on waste preparation, handling, and feeding; incinerator type, performance, size, and cost; air pollution control (APC) type and size; and residue handling. Key physical parameters include waste matrix physical characteristics (type of matrix, physical form, handling properties, and particle size), moisture content, and heating value. Key chemical parameters include the type and concentration of organic compounds including PCBs and dioxins, inorganics (metals), halogens, sulfur, and phosphorous.

The effectiveness of mobile/transportable incineration on general contaminant groups for various matrices is shown in Table 1 [7, p. 9]. Examples of constituents within contaminant groups are provided in Reference 7, "Technology Screening Guide for Treatment of CERCLA Soils and Sludges." This table

* [reference number, page number]

Table 1
Effectiveness of Incineration on General Contaminant Groups for Soil, Sediment, Sludge, and Liquid

	Contaminant Groups	Soil/ Sediment	Sludge	Liquid
Organic	Halogenated volatiles	■	■	■
	Halogenated semivolatiles	■	■	■
	Nonhalogenated volatiles	■	■	■
	Nonhalogenated semivolatiles	■	■	■
	PCBs	■	■	■
	Pesticides (halogenated)	▼	■	■
	Dioxins/Furans	■	■	■
	Organic cyanides	▼	▼	▼
	Organic corrosives	▼	▼	▼
Inorganic	Volatile metals	❑	❑	❑
	Nonvolatile metals	❑	❑	❑
	Asbestos	❑	❑	❑
	Radioactive materials	❑	❑	❑
	Inorganic corrosives	❑	❑	❑
	Inorganic cyanides	▼	▼	▼
Reactive	Oxidizers	▼	▼	▼
	Reducers	▼	▼	▼

■ Demonstrated Effectiveness: Successful treatability test at some scale completed
▼ Potential Effectiveness: Expert opinion that technology will work
❑ No Expected Effectiveness: Expert opinion that technology will not work

is based on current available information or professional judgment when no information was available. The proven effectiveness of the technology for a particular site or waste does not ensure that it will be effective at all sites or that the treatment efficiency achieved will be acceptable at other sites. For the ratings used for this table, demonstrated effectiveness means that, at some scale, treatability was tested to show that the technology was effective for a particular contaminant and matrix. The ratings of potential effectiveness or no expected effectiveness are based upon expert judgment. Where potential effectiveness is indicated, the technology is believed capable of successfully treating the contaminant group in a particular matrix. When the technology is not applicable or will probably not work for a particular combination of contaminant group and matrix, a no-expected-effectiveness rating is given. Other sources of general observations and average removal efficiencies for different treatability groups are the Superfund LDR Guide #6A, "Obtaining a Soil and Debris Treatability Variance for Remedial Actions," (OSWER Directive 9347.3-06FS [13], and Superfund LDR Guide #6B, "Obtaining a Soil and Debris Treatability Variance for Removal Actions," (OSWER Directive 9347.3-07FS [14].

Limitations

Toxic metals such as arsenic, lead, mercury, cadmium, and chromium are not destroyed by combustion. As a result, some will be present in the ash while others are volatilized and released into the flue gas [1, pp. 3-6].

Alkali metals, such as sodium and potassium, can cause severe refractory attack and form a sticky, low-melting-point submicron particulate, which causes APC problems. A low feed stream concentration of sodium and potassium may be achieved through feed stock blending [1, pp. 3-11].

When PCBs and dioxins are present, higher temperatures and longer residence times may be required to destroy them to levels necessary to meet regulatory criteria [7, p. 34].

Moisture/water content of waste materials can create the need to co-incinerate these materials with higher BTU streams, or to use auxiliary fuels.

The heating value (BTU content) of the feed material affects feed capacity and fuel usage of the incinerator. In general, as the heating value of the feed increases, the feed capacity and fuel usage of the incinerator will decrease. Solid materials with high calorific values also may cause transient behaviors that further limit feed capacity [9, p. 4].

The matrix characteristics of the waste affect the pretreatment required and the capacity of the incinerator and can cause APC problems. Organic liquid wastes can be pumped to and then atomized in the incinerator combustion chamber. Aqueous liquids may be suitable for incineration if they contain a substantial amount of organic matter. However, because of the large energy demand for evaporation when treating large volumes of aqueous liquids, pretreatment to dewater the waste may be cost effective [1, pp. 3-14]. Also, if the organic content is low, other methods of treatment may be more economical. For the infrared incinerator, only solid and solid-like materials within a specific size and moisture content range can be processed because of the unique conveyor belt feed system within the unit.

Sandy soil is relatively easy to feed and generally requires no special handling procedures. Clay, which may be in large clumps, may require size reduction. Rocky soils usually require screening to remove oversize stones and boulders. The solids can then be fed by gravity, screw feeder, or ram-type feeder into the incinerator. Some types of solid waste may also require crushing, grinding, and/or shredding prior to incineration [1, pp. 3-17].

The form and structure of the waste feed can cause periodic jams in the feed and ash handling systems. Wooden pallets, metal drum closure rings, drum shards, plastics, trash, clothing, and mud can cause blockages if poorly prepared. Muddy soils can stick to waste processing equipment and plug the feed system [9, p. 8].

The particle size distribution of the ash generated from the waste can affect the amount of particulate carry-over from the combustion chamber to the rest of the system [9, p. 16].

Incineration of halogens, such as fluorine and chlorine, generates acid gases that can affect the capacity, the water removal and replacement rates that control total dissolved solids in the process water system, and the particulate emissions [9, p. 12]. The solutions used to neutralize these acid gases add to the cost of operating this technology.

Organic phosphorous compounds form phosphorous pentoxide, which attacks refractory material, causes slagging problems and APC problems. Slagging can be controlled by feed blending or operating at lower temperatures [1, pp. 3-10].

Technology Description

Figure 1 is a schematic of the mobile/transportable incineration process.

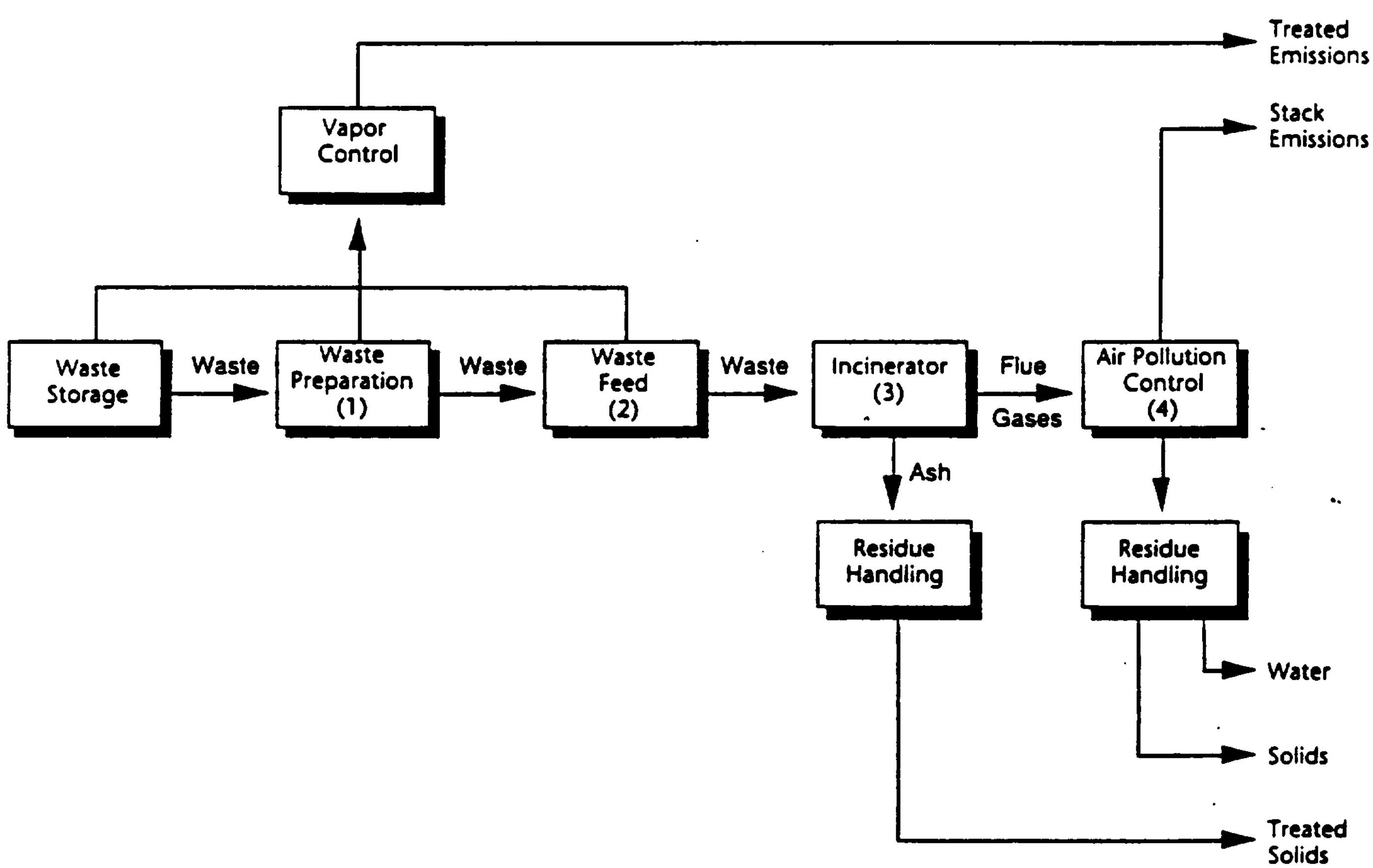
Waste preparation (1) includes excavation and/or moving the waste to the site. Depending on the requirements of the incinerator type for soils and solids, various equipment is used to obtain the necessary feed size. Blending is sometimes required to achieve a uniform feed size and moisture content or to dilute troublesome components [1, pp. 3-19].

The waste feed mechanism (2), which varies with the type of the incinerator, introduces the waste into the combustion system. The feed mechanism sets the requirements for waste preparation and is a potential source of problems in the actual operation of incinerators if not carefully designed [1, pp. 3-19].

Different incinerator designs (3) use different mechanisms to obtain the temperature at which the furnace is operated, the time during which the combustible material is subject to that temperature, and the turbulence required to ensure that all the combustible material is exposed to oxygen to ensure complete combustion. Three common types of incineration systems for treating contaminated soils are rotary kiln, circulating fluidized bed, and infrared.

The rotary kiln is a slightly inclined cylinder that rotates on its horizontal axis. Waste is fed into the high end of the rotary kiln and passes through the combustion chamber by gravity. A secondary combustion chamber (afterburner) further destroys unburned organics in the flue gases [7, p. 40].

Figure 1
Mobile/Transportable Incineration Process



Circulating fluidized bed incinerators use high air velocity to circulate and suspend the fuel/waste particles in a combustor loop. Flue gas is separated from heavier particles in a solids separation cyclone. Circulating fluidized beds do not require an afterburner [7, p. 35].

Infrared processing systems use electrical resistance heating elements or indirect fuel-fired radiant U-tubes to generate thermal radiation [1, pp. 4-5]. Waste is fed into the combustion chamber by a conveyor belt and exposed to the radiant heat. Exhaust gases pass through a secondary combustion chamber.

Offgases from the incinerator are treated by the APC equipment to remove particulates and capture and neutralize acids (4). Rotary kilns and infrared processing systems may require both external particulate control and acid gas scrubbing systems. Circulating fluidized beds do not require scrubbing systems because limestone can be added directly into the combustor loop but may require a system to remove particulates [1, pp. 4-11] [2, p. 32]. APC equipment that can be used include venturi scrubbers, wet electrostatic precipitators, baghouses, and packed scrubbers.

Process Residuals

Three major waste streams are generated by this technology: solids from the incinerator and APC system, water from the APC system, and emissions from the incinerator.

Ash and treated soil/solids from the incinerator combustion chamber may be contaminated with heavy metals. APC system solids, such as fly ash, may contain high concentrations of volatile metals. If these residues fail required leachate toxicity tests, they can be treated by a process such as stabilization/solidification and disposed of onsite or in an approved landfill [7, p. 126].

Liquid waste from the APC system may contain caustic, high chlorides, volatile metals, trace organics, metal particulates, and inorganic particulates. Treatment may require neutralization, chemical precipitation, reverse osmosis, settling, evaporation, filtration, or carbon adsorption before discharge [7, p. 127].

The flue gases from the incinerator are treated by APC systems such as electrostatic precipitators or venturi scrubbers before discharge through a stack.

Site Requirements

The site should be accessible by truck or rail and a graded/gravel area is required for setup of the system. Concrete pads may be required for some equipment (e.g., rotary kiln). For a typical 5 tons per hour commercial-scale unit, 2 to 5 acres are required for the overall system site including ancillary support [10, p. 25].

Standard 440V three-phase electrical service is needed. A continuous water supply must be available at the site. Auxiliary fuel for feed BTU improvement may be required.

Contaminated soils or other waste materials are hazardous and their handling requires that a site safety plan be developed to provide for personnel protection and special handling measures.

Various ancillary equipment may be required, such as liquid/sludge transfer and feed pumps, ash collection and solids handling equipment, personnel and maintenance facilities, and process-generated waste treatment equipment. In addition, a feed-materials staging area, a decontamination trailer, an ash handling area, water treatment facilities, and a parking area may be required [10, p. 24].

Proximity to a residential neighborhood will affect plant noise requirements and may result in more stringent emissions limitations on the incineration system.

Storage area and/or tanks for fuel, wastewater, and blending of waste feed materials may be needed.

No specific onsite analytical capabilities are necessary on a routine basis; however, depending on the site characteristics or a specific Federal, State, or local requirement, some analytical capability may be required.

Performance Data

More than any other technology, incineration is subject to a series of technology-specific regulations, including the following Federal requirements: the Clean Air Act 40 CFR 52.21 for air emissions; Toxic Substances Control Act (TSCA) 40 CFR 761.40 for PCB treatment and disposal; National Environmental Policy Act 40 CFR 6; RCRA 40 CFR 261/262/264/270 for hazardous waste generation, treatment performance, storage, and disposal standards; National Pollutant Discharge Elimination System 33 U.S.C. 1251 for discharge to surface waters; and the Noise Control Act P.L. 92-574. RCRA incineration standards have been proposed that address metal emissions and products of incomplete combustion. In addition, State requirements must be met if they are more stringent than the Federal requirements [1, p. 6-1].

All incineration operations conducted at CERCLA sites on hazardous waste must comply with substantive and defined Federal and State applicable or relevant and appropriate requirements (ARARs) at the site. A substantial body of trial burn results and other quality assured data exists to verify that incinerator operations remove and destroy organic contaminants from a variety of waste matrices to the parts per billion or even the parts per trillion level, while meeting stringent stack emission and water discharge requirements. The demonstrated treatment systems that will be discussed in the technology status section, therefore, can meet all the performance standards defined by the applicable Federal and State regulations on waste treatment, air emissions, discharge of process waters, and residue ash disposal [1, p. A-1] [4, p. 4] [10, p. 9].

RCRA Land Disposal Restrictions (LDRs) that require treatment of wastes to best demonstrated available technology (BDAT) levels prior to land disposal may sometimes be determined to be ARARs for CERCLA response actions. The solid residuals from the incinerator may not meet required treatment levels in all cases. In cases where residues do not meet BDAT levels, mobile incineration still may be selected, in certain situations, for use at the site if a treatability variance establishing alternative treatment levels is obtained. EPA has made the treatability variance process available in order to ensure that LDRs do not unnecessarily restrict the use of alternative and innovative treatment technologies. Treatability variances may be justified for handling complex soil and debris matrices. The following guides describe when and how to seek a treatability variance for soil and debris: Superfund LDR Guide #6A, "Obtaining a Soil and Debris Treatability Variance for Remedial Actions," (OSWER Directive 9347.3-06FS) [13] and Superfund LDR Guide #6B, "Obtaining a Soil and Debris Treatability Variance for Removal Actions," (OSWER Directive 9347.3-07FS) [14].

Technology Status

To date, 49 of the 95 RODs designating thermal remedies at Superfund sites have selected onsite incineration as an integral part of a preferred treatment alternative.

Table 2 lists the site experience of the various mobile/transportable incinerator systems. It includes information on the incinerator type/size, the site size, location, and contaminant source or waste type treated [5] [3, p. 80] [8, p. 74].

The cost of incineration includes fixed and operational costs. Fixed costs include site preparation, permitting, and mobilization/demobilization. Operational costs such as labor, utilities, and fuel are dependent on the type of waste treated and the size of the site. Figure 2 gives an estimate of the total cost for incinerator systems based on site size [12, pp. 1-3]. Superfund sites contaminated with only volatile organic compounds can have even lower costs for thermal treatment then the costs shown in Figure 2.

EPA Contact

Technology-specific questions regarding mobile/transportable incineration may be directed to Donald A. Oberacker, U.S. EPA Risk Reduction Engineering Laboratory, 26 West Martin Luther King Drive, Cincinnati, Ohio 45268, telephone: FTS 684-7510 or (513) 569-7510.

Table 2.
Technology Status

Treatment System/ Vendor	*Thermal Capacity (MM BTU/Hr)*	*Experience*		
		Site, Location	*Waste Volume (tons)*	*Contaminant Source or Waste Type*
Rotary Kiln *Ensco*	35	Sydney Mines, Valrico, FL^	10,000	Waste oil
		Lenz Oil NPL Site, Lemont, IL^	26,000	Hydrocarbon - sludge/solid/liquid
		Naval Construction Battalion Center (NCBC), Gulfport, MS	22,000	Dioxin/soil
		Union Carbide, Seadrift, TX*	N/A	Chemical manufacturing
		Smithiville, Canada*	7,000	PCB transformer leaks
	100	Bridgeport Rental, Bridgeport, NJ*^	100,000	Used oil recycling
Rotary Kiln *IT*	56	Cornhusker Army Ammunition Plant (CAAP), Grand Island, NE^	45,000	Munitions plant redwater pits
		Louisiana Army Ammunition Plant (LAAP), Shreveport, LA*^	100,000	Munitions plant redwater lagoon
		Motco, Texas City, TX*^	80,000	Styrene tar disposal pits
Rotary Kiln *Vesta*	8	Fairway Six Site, Aberdeen, NC	50	Pesticide dump
	12	Fort A.P. Hill, Bowling Green, VA	200	Army base
		Nyanza/Nyacol Site, Ashland, MA^	1,000	Dye manufacturing
		Southern Crop Services Site Delray Beach, FL	1,500	Crop dusting operation
		American Crossarm & Conduit Site Chehalis, WA^	900	Wood treatment
		Rocky Boy, Havre, MT*	1,800	Wood treatment

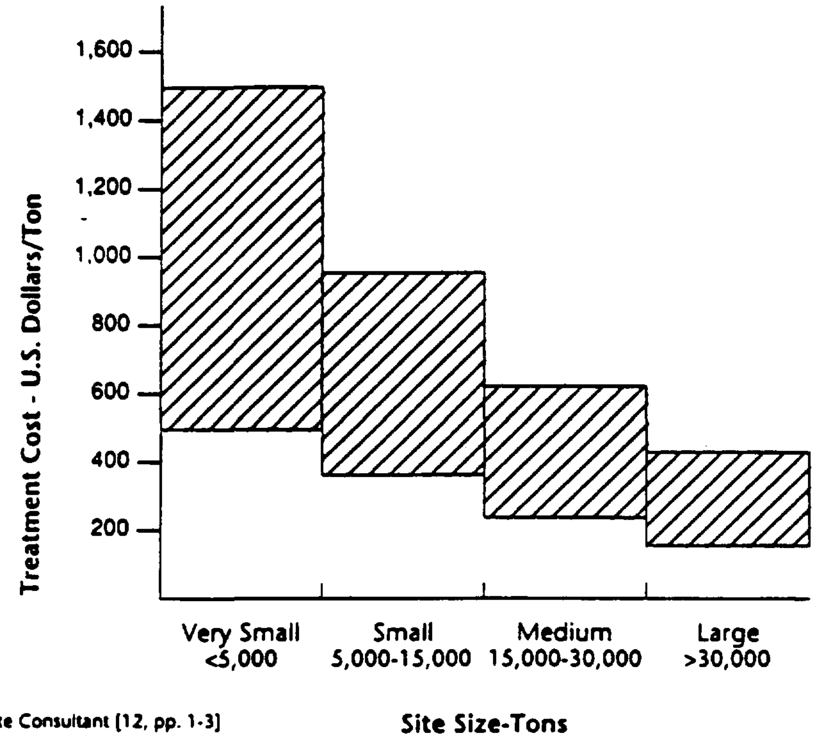
NA - Not available * Contracted, others completed ^ Superfund Site [Source: References 3, 5, 8]

Table 2
Technology Status (Continued)

Treatment System/ Vendor	*Thermal Capacity (MM BTU/Hr)*	*Experience*		
		Site, Location	*Waste Volume (tons)*	*Contaminant Source or Waste Type*
Rotary Kiln *Weston*	35	Lauder Salvage, Beardstown, IL Paxton Ave., Chicago, IL*	8,500 16,000	Metal scrap salvage Waste lagoon
Rotary Kiln *AET*	20	Valdez, AK	NA	Crude oil spill
Rotary Kiln *Boliden*	40	Oak Creek, WI	50,000	Dye manufacturing
Rotary Kiln *Harmon*	82	Prentis Creosote & Forest Products Prentis, MS Bog Creek, Howell Township, NJ▲	9,200 22,500	Creosote/soil Organics
Rotary Kiln *Bell*	30	Bell Lumber&Pole, New Brighton, MN▲	21,000	Wood treatment
Rotary Kiln *Kimmins*	100	Lasalle, IL*▲	69,000	PCB capacitor manufacturing
Rotary Kiln *USEPA*	10	Denney Farm, MO	6,250	Dioxin Soils
Rotary Kiln *Vertac*	35	Vertac, Jacksonville, AR*▲	6,500	Chemical manufacturing
Shirco Infrared *Haztech*	30	Peak Oil, Tampa, FL▲ Lasalle, IL▲	7,000 30,000	Used oil recycling, PCBs/Lead Transformer reconditioning
Shirco Infrared *GDC Engr.*	NA	Rubicon, Geismar, LA*	52,000	Chemical manufacturing
Shirco Infrared *OH Materials*	30	Florida Steel, Indiantown, FL▲ Twin City AAP, New Brighton, MN Goosebay, Canada	18,000 2,000 4,000	Steel mill used oils Munitions plant PCBs
	12	Gas Station Site, Cocoa, FL	1,000	Petroleum tank leak
Shirco Infrared *U.S. Waste*	10	Private Site, San Bernadino, CA	5,400	Hydrocarbons
Circulating Bed Combustor *Ogden*	10	Arco Swanson River Field Kenai, AK* Stockton, CA*	80,000 16,000	Oil pipeline compressor oil Underground tank oil leak

NA - Not available   * Contracted, others completed   ▲Superfund Site   [Source: References 3, 5, 8]

Figure 2
Effect of Site Size on Incineration Costs



Source: The Hazardous Waste Consultant [12, pp. 1-3]

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